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PATENT APPLICATION

FOR

WEAR PROTECTION FOR A ROCK CRUSHING SYSTEM

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WEAR PROTECTION FOR A ROCK CRUSHING SYSTEM

FIELD OF THE INVENTION

The present invention relates to rock crushers or crushing systems utilized for comminuting or breaking rock, coal, waste, and ore-like materials. Certain elements of such crushers are subjected to considerably more wear than others, particularly from contact with the material being crushed. These elements are frequently protected by more wear resistance components, which components are designed to be replaceable.

BACKGROUND OF THE INVENTION

One form of crusher which is frequently used for crushing or comminuting minerals, rock, coal, waste and other ore-like materials is a conical crusher. The conical crusher has a downwardly expanding central conical member which rotates or gyrates within an outer downwardly expanding frustroconically shaped member typically called a bowl. The central conical member generally has a wearing cover or liner typically called a mantle. The outside surface of the mantle provides a crushing surface for the rock crusher. The bowl is also provided with a wearing cover or liner, which forms the other crushing surface.

Another form of crusher which is frequently utilized for primary crushing operations is a gyratory crusher. The gyratory crusher has a downwardly expanding central conical member which rotates or gyrates within an outer upwardly expanding frustroconically shaped member typically called a shell. The shell can be comprised of two or more pieces, e.g., a top shell and a bottom shell. The central conical member generally has a wearing cover or a liner called a mantle. The mantle can be one or more pieces. The outside surface of the mantle provides a

crushing surface for the rock crusher. The shell is also protected by a wearing cover or liner which provides the other crushing surface.

Conventional wearing covers or liners disposed over the shell are comprised of four-sided segments formed with a curvature appropriate to fit against the cylindrical surface of the shell. Liners formed from segments are utilized as opposed to one-piece liners. Liners formed from segments reduce susceptibility to breaking and bending caused by crushing forces and imperfect dimensional fits resulting from casting tolerances. The segments are typically called concaves and are formed of cast or fabricated steel.

The concaves are manually attached to the inside surface of the shell. A backing material, such as zinc, epoxy, or other adhesive, holds the concaves to the inside surface, fills gaps, and provides a uniform support surface. Concaves generally have a curvilinear outside and inside surface. The outside surface faces the inside surface of the shell, and the inside surface is the crushing surface that is opposite the mantle. Concaves can be arranged in rows over the inside surface of the top shell and the bottom shell of the gyratory crusher. For example, one type of gyratory crusher manufactured by Nordberg, Inc. of Milwaukee, Wisconsin can have five rows of concaves covering a top shell and a bottom shell.

The outside surface of each concave typically includes a recessed portion between the feet or outer bands. The recessed portion provides a gap between the outside surface of the concave and the inside surface of the top shell. Backing material is placed in the recessed portion or gap between the shell and the concave.

Installing the relatively small concaves is labor intensive and increases the cost associated with repairing and assembling rock crushers. The

application of the concaves is time consuming, and improperly installed elements can be subject to loosening and falling out. In addition, the concaves must be positioned on the inside surface of the shell so that the concaves do not interfere with the operation of other elements, such as, the spider, the mantle, or other structures.

Thus, it is desirable to provide wear resistant segments or concaves in a form which are not susceptible to bending or breaking and yet can be more easily installed. Further, there is a need for concaves which are more easily aligned when installed. Further, there is a need for a concave which is less susceptible to movement in a vertical direction.

SUMMARY OF THE INVENTION

An exemplary embodiment relates to a wear resistant band for providing a wear protection surface over an inside surface of a cylindrical member in a rock crusher. The cylindrical wear resistant band includes a cast piece that includes curvilinear segments. The curvilinear segments are separated from each other by a portion of reduced thickness. The portion of reduced thickness can be cut to separate the curvilinear segments after installation to the inside surface of the cylindrical member in the rock crusher.

Another embodiment relates to a wear protection arrangement for a surface of a rock crusher. The wear protection arrangement protects the surface from wear. The surface supports a crushing operation of the rock crusher. The wear protection arrangement includes curvilinear segments connected by a portion of reduced thickness.

Still another embodiment relates to a method of repairing or manufacturing a rock crusher. The rock crusher has a shell. The shell is exposed

to wear when the rock crusher is operational. The method includes the step of attaching a one piece wear band including segments to the shell.

Still another exemplary embodiment relates to a concave for a gyratory crusher. The gyratory crusher includes a shell and a spider. The shell has a concave surface. The shell and the spider define a recess. The concave includes a top end having a flange and lip. The flange is configured to be received in the recess. The lip extends above the flange.

A still further embodiment relates to a gyratory crusher including a top shell, a spider disposed over a shell, and a concave. The shell and the spider define a recess. The concave covers at least a portion of the shell. The concave includes a top end having a flange and a lip. The flange is configured to be received in a recess. The lip extends above the flange.

Yet another embodiment relates to a method of repairing or assembling a gyratory rock crusher including a spider and a shell. The method includes placing a concave element on a rim of the shell, and disposing the spider over the shell. The concave element includes a flange and a lip. The flange rests on the rim of the shell. Disposing the spider over the shell captures the flange between the spider and the rim of the shell.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiments will hereafter be described with reference to the accompanying drawings, wherein like numerals denote like elements; and

FIGURE 1 is a planar top view of a gyratory crusher having concaves in accordance with an exemplary embodiment of the present invention;

FIGURE 2 is a planar side view of the gyratory crusher illustrated in FIGURE 1;

FIGURE 3 is a cross-sectional view of the gyratory crusher illustrated in FIG. 1 about line 3-3 of the gyratory crusher, showing concaves in accordance with exemplary embodiments of the present invention;

FIGURE 4 is a more detailed cross sectional view of one of the concaves illustrated in FIG. 3, showing a flange in accordance with one alternative embodiment;

FIGURE 5 is a more detailed cross sectional view of a one of the concaves illustrated in FIG. 3, showing grooves on an outside surface in accordance with another alternative embodiment; and

FIGURE 6 is a more detailed cross sectional view of a one of the concaves illustrated in FIG. 3, showing grooves on an inside surface in accordance with yet another exemplary embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGURES 1, 2 and 3, a gyratory crusher 10 can be utilized to crush rock, ore, minerals, waste, or other material. Gyratory crusher 10 is assembled on a cast steel base or bottom shell 12 having a central hub 14. Central hub 14 is provided with cylindrical vertical bore 18 adapted to receive a cylindrical support shaft 20. Pinion drive mechanism 22 causes rotation of an eccentric 24 which directs the gyratory motion of the shaft 20.

A head assembly 26, which is part of the shaft 20, includes a head member 30 which is covered by a two-piece mantle 34. Mantle 34 provides one of the crushing surfaces of crusher 10.

A top shell 36 projects upwardly from bottom shell 12 and is covered by a spider assembly including a spider 39. Alternatively, top shell 36 and bottom shell 12 can be a single piece component. Spider 39 includes an aperture 40 that receives an end 42 of shaft 20. Vertical positioning of shaft 20 with respect to top shell 36 adjusts the relative position of the mantle 34 of the head assembly 26 with respect to concaves 60, thereby adjusting the size of the crushed material exiting crusher 10. Concaves 60 are discussed below in greater detail with reference to Figures 4-6.

Material to be crushed is supplied through spider 39 which includes openings 48 for entry of the material into crushing cavity 50. A liquid flush apparatus (not shown) may be provided for spraying a liquid, such as, water toward the crusher cavity 50.

Top shell 36 and portions of bottom shell 12 are protected from wear by several rows of concaves 60. Concaves 60 can be any type of polygons, such as, four sided or three sided polygons and can be in the shape of rectangles, squares, trapezoids, triangles, parallelograms or other polygons. Concaves 60 are arranged in rows 62, 64, 66 and 68. Concaves 60 have an ~~inner~~ outer surface 63 which faces an inner surface 65 of shells 36 and 12. A recess 72 is provided in each concave 60. Recess 72 provides a gap between ~~inner~~ outer surface 63 of concave 60 and inner surface 65 of shells 36 and 12 for backing material, such as, concrete or other adhesive.

Rows 62, 64, and 66 cover an entire inner surface 65 of top shell 36, and row 68 may cover a portion of inner surface 65 of bottom shell 12. Concaves 60 associated with row 68 may be supported by a flange 74 of bottom shell 12 or a support attached to bottom shell 12 or to top shell 36. Row 66 of concaves 60 is supported by row 68 of concaves 60. Row 64 of concaves 60 is supported by row

66 of concaves 60, and row 62 of concaves 60 is supported by row 64. Flange 84 (shown in FIGURE 4) also supports row 62 of concaves 60.

Concaves 60 are shown in FIGURE 3 as separate pieces. However, to advantageously reduce manufacturing and maintenance costs, concaves 60 can be installed in unitary pieces including two or more concaves 60 separated by a portion having a reduced thickness, created by the insertion of furrows or grooves 90, discussed in greater detail with reference to FIGURES 5 and 6. Grooves 90 can be cut though by a welding torch or a mechanical saw after installation of concaves 60 to inner surface 65 of shells 12 and 36. Concaves 60 can be formed of a ceramic material, or an iron based material.

In FIGURE 4, a more detailed drawing of one of concaves 60 in row 62 (FIGURE 3) is shown. Concave 60 includes a top end 78 which includes a lip 82 and a flange 84. Top end 78 also includes an aperture 86 through which backing material 93 can be poured between inner surface 65 of top shell 36 and ~~inner~~ outer surface 63 of concaves 60.

Spider 39 can be attached or rest upon top shell 36. Preferably top shell 36 includes a recessed portion 92 for receiving a flange 94 of spider 39. In addition, spider 39 and top shell 36 define a recess 96 for capturing flange 84 of concaves 60. Backing material 93 can also be provided within recess 96. Recess 96 is defined by bottom surface 98 of spider 39 and a rim 102 of top shell 36 and a perpendicular wall 104 of top shell 36. The backing material 93 eliminates clearance between the concave 60 and the top shell 36 and spider 39.

Flange 84 of concaves 60 prevents concaves 60 from sliding vertically (e.g., downward). Lip 82 is preferably 1.5 inches higher than a top surface 80 of flange 84, and one inch higher than the bottom surface 98 of spider

39. In the preferred embodiment, lip 82 is integral with concaves 60. However, in an alternative embodiment, lip 82 could be a temporary structure made of any suitable material. Flange 84 is preferably three inches wide and two inches thick. The flange 84 may be segmented along the length of concaves 60. The segmented structure creates a natural aperture 86 in the form of a slot. When the flange 84 is not segmented, aperture 86 is preferably one inch in diameter. Concave 60 shown in FIGURE 4 is preferably three inches thick from surface 63 to a crushing surface 83.

Flange 84 and lip 82 advantageously allow backing to be poured into the gap between spider 39 and lip 82 and through aperture 86 without spilling onto crushing surface 83 of concave 60. Thus lip 82 can be made of any material that prevents spillage onto crushing surface 83. Flange 84 also advantageously eliminates the potential for concave movement. Thus, flange 84 provides positive positioning and stable support. Flange 84 prevents concaves 60 from falling during installation and provides absolute vertical restraint.

With reference to FIGURE 5, several concaves 60 (FIGURE 3) are shown as a one-piece casting 150. Concaves 60 are curvilinear segments separated by portions having a reduced thickness, created by the insertion of slits or grooves 90. A one-piece casting can be utilized in any of rows 62, 64, 66 or 68 (FIGURE 3). Preferably, a one-piece casting 150 covers an arc length of at least 45°. One-piece casting 150 can be applied in one of rows 62, 64, 66 and 68. After application to inner surface 65 of top shell 36 or bottom shell 12, concaves 60 may be separated by cutting either mechanically or with a heat torch along grooves 90. One-piece casting 150 is cut to reduce the potential for bending and breakage due to crushing forces and imperfect dimensional fits resulting from casting tolerances.

Alternatively, one-piece casting 150 may be constructed without grooves 90. Concaves 60 may still be separated by cutting either mechanically or with a heat torch into the desired number of segments after installation if desired

As a further alternative, one-piece casting 150 may be utilized without cutting into a number of separate concaves 60 after installation. This alternative may be preferred with respect to row 68.

In the exemplary embodiment in FIGURE 5, grooves 90 extend vertically. However, horizontal grooves could also be utilized. Generally, casting 150 can be made as large as possible including a large group (two or more) of concaves 60. For example, in sections of shells 12 and 36 which are narrower, casting 150 can cover an entire 360° arc. In another alternative embodiment, casting 150 can cover an arc length of 180° or 90°. Preferably, segments 60 are twenty inches high and twenty inches wide. Concaves 60 are preferably cast steel. Concaves 60 are one inch thick at grooves 90 and three inches thick at locations outside of grooves 90.

In FIGURE 6, a casting 158 similar to casting 150 is shown. Casting 158 includes grooves 162 on an inside surface 164 of concaves 60. When grooves 162 are located on the inside surface 164, it may not be necessary to separate concaves 60 by cutting along grooves 162. Under wear, manganese steel, a typical concave 60 material, tends to expand. Grooves 162 will allow the expansion of casting 158 by closing grooves 162. Thus, growth can be allowed until grooves 162 close completely, creating a solid ring of concaves 60, then requiring cutting to relieve the resultant stress on the machine. The size of castings 150 and 158 are only limited by the manageable sizes for transportation and foundry operations. Grooves 162 are on the order of one half inch wide and concaves 60 are on the

order of one inch thick at grooves 162 and three inches thick at locations outside of grooves 162.

While one embodiment of the invention has been shown, it should be apparent to those skilled in the art that what has been described is considered at present to be a preferred embodiment of a wear band for a crusher. However, in accordance with the patent statutes, changes may be made in the wear resistant band without actually departing from the true spirit and scope of this invention. The wear band or concaves can be utilized on a variation of crusher components and within different types of crushers. The appended claims are intended to cover all such changes and modifications which fall within the true spirit and scope of this invention.